Heliyon 10 (2024) e37267

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Government digitalization and its influence on government functions transformation adopting a Structural Functionalism perspective: Evidence from county-level governments in China

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A R T I C L E I N F O

Keywords:
Government digitalization
Government functions transformation
Structural Functionalism
Government reform

A B S T R A C T

A proactive and innovative approach to government digital reform is necessary to ad-dress potential explanations for the sustained influence of government digitalization, thereby optimizing the behavior and performance of government functions transformation. This study constructs a theoretical framework for understanding the driving mechanisms of government digitalization on government functions transformation from a Structural Functionalism perspective. Based on subdividing government digitalization into four dimensions and government functions transformation into two dimensions, a survey questionnaire with high validity and reliability was compiled and distributed. Utilizing Structural Equation Model, the study investigated the driving mechanisms of government digitalization on government functions transformation and their spatial variations as follows: (1) Digitalization Planning underscores its decisive role in local government functions transformation. (2) Digitalization Technology has a substantial direct impact on Digitalization Platform. (3) Digitalization Policy directly affects Digitalization Platform, behavior, and performance of government functions transformation. (4) Digitalization Platform exerts the most direct impact on government functions transformation. Additionally, the driving mechanisms of government digitalization on government functions transformation exhibit both commonalities and differences across the East, Center, and West of China.

1. Introduction

The rapid evolution of information technology, along with the ubiquitous utilization of the Internet, has greatly expedited the exchange of information. Digitalization technologies, such as the Internet of Things (IoT), blockchain, and AI, have emerged as pivotal catalysts for organizational transformation [1,2]. Diverse entities, including governmental bodies, must delve deeper into the exploration and fortification of digitalization technologies. The transformative potential of these technologies empowers governments to reshape their functions and redefine their interfaces with markets and society. These advancements propel governmental digital reforms, potentially paving the way for a modernized government characterized by citizen-centricity, collaborative governance, and efficient standardization.

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https://doi.org/10.1016/j.heliyon.2024.e37267
Received 26 March 2024; Received in revised form 27 August 2024; Accepted 29 August 2024
Available online 1 September 2024

Research suggests that change advocates with innovative ideas, particularly policy entrepreneurs in influential organizational positions, can propel organizational change by synchronizing with the "window of opportunity" for reform [3]. This implies that reform concepts advocated and championed by leaders serve as pivotal driving forces for organizational change [4]. The concept of government digitalization, acting as a source of intellectual impetus and a "window of opportunity", significantly influences organizational change. Representative perspectives indicate that various environmental factors, encompassing organizational resources, policies, and procedures, shape reform ideas and intentions (change commitment and change efficacy), thereby engendering a series of change behaviors (initiating change, sustaining change, and cooperative actions), ultimately culminating in change performance [5].

Rapid advancements in digital technology have become essential in government functions transformation, highlighting the need for digital elements in digital government construction. As academic discourse on the intersection of digitalization and governance deepens, the application of digital technology to reengineer and optimize government processes is increasingly recognized. Notable achievements in this field have focused on "promotion" [6] and the interplay between surface-level and in-depth digitalization [7]. The focus now is on systematically redefining government functions' boundaries through digital reform. Studies on the impact of big data and digitalization platforms on public governance [8,9] are gaining traction.

However, digitalization transformation demands significant resources and carries substantial risks [10,11]. In local government practice, a common misconception prevails: the notion that merely investing substantial funds, adopting advanced digitalization technologies, and deploying large screens and visual aids can rapidly expedite government functions transformation. However, the reality is that government digitalization does not immediately propel government functions transformation as this process is non-linear. Research suggests that unreasonable implementation may lead to adverse outcomes: (1) Increased administrative burden: While the original intent of government digitalization is to reduce administrative loads, it often fails to synchronize institutional reforms within and outside organizations with the integration and application of information technology, resulting in heightened administrative burdens [12]. (2) Imbalanced discretionary power allocation: Leaders leveraging digitalization technologies may wield significant online informational power. Effective, timely, and thorough supervision of subordinates through network control and information dissemination may inadvertently impede authority decentralization, depriving grassroots administrative personnel of their discretionary power [13]. (3) Fragmentation of government affairs: Partial investment in funds and technology frequently leads to data fragmentation within government, low levels of information sharing, and situations where civil servants must personally undertake various work, regulatory, and service-related tasks [14].

Current research on the relationship between government digitalization and functions transformation mainly examines how public governance and institutional rules are reshaped out of necessity. However, there is still a lack of comprehensive responses to these challenges. A pressing issue is the need to reconstruct the boundaries, organizational structures, and governance methods of government functions through digital reform. How can we address the potential explanations for the sustained influence of government digitalization on government functions transformation within a comprehensive theoretical framework? Does government digitalization indeed influence government functions transformation, and what characteristics define its driving pathways? Innovative and proactive government digital reforms are needed, involving in-depth analyses of digital demands across different levels of government functions transformation, while continuously optimizing behaviors and performance.

2. Theoretical framework and research hypothesis

2.1. Theoretical framework

Structural Functionalism offers a fresh perspective for understanding how government digitalization drives government functions transformation sustainably. Talcott Parsons, since the 1950s, has evolved the concept of "social structure" from functional differentiation into a comprehensive theoretical framework explaining social issues. According to Structural Functionalism, society operates as an interconnected system where realizing functions and balancing subsystems are essential for normal social operation [15]. Local government transformation involves multi-level subsystems with distinct functions, influencing government functions manifestation and reciprocally impacting each other. The evolution of subsystems across various levels invariably shapes the manifestation of government functions, indicating shifts in government functions transformation. Moreover, the exertion of these functions mutually influences the overall structure, reciprocally impacting each level of subsystems. Government digitalization emerges as a critical driver for government functions transformation in the digital era, determining operational characteristics and behavioral logic of this change.

2.1.1. Dimension and Conduction Paths of Government Digitalization

Research on structural elements driving organizational change has proposed two analytical paths. One is the "planning-execution" approach, emphasizing planning factors' pivotal role. The other, the "planning-resources-execution" approach, adds resource considerations to planning factors. It suggests that for change initiatives to succeed, organizations need ample resources, particularly those serving members effectively [16]. Past models fragmented factors like vision, planning, participation, policy, technology, and control [17–19]. Integrating the driving mechanisms of government digitalization on government functions transformation requires further consolidation within a holistic model.

Anthony Giddens views "structure" as rules and resources in sustainably evolving social systems [20]. Within Structural Functionalism, characteristic patterns of elements can be deduced from a resource perspective. Giddens classifies resources into two: authoritative and allocative. Authoritative resources empower individuals within the political system, while allocative resources are applied to entities during power exercise. Practical utilization of authoritative and allocative resources is crucial, emphasizing practice's role in rule and resource use. Interdependence among entities drives change since no single entity can access all resources.

Governments, controlling most authoritative resources, have the will and capability to guide and manage allocative resources during transformative endeavors.

In many countries, decentralization of authority between central and local governments occurs through a hierarchical system. Function allocation cascades, driven by central government regulations and public policies, configure local government functions. Andersen and others noted Denmark's centralized local government reforms [21]. The central government, as the primary driver of reform, launched an extensive restructuring of economic and labor market policy management networks. Viewed through the lens of Anthony Giddens' division, government digitalization transforms authoritative resources into allocative resources through guidance and management, leading to government functions transformation. Examining the process from this viewpoint reveals a transmission mechanism concerning local government functions transformation amid digitalization: digitalization planning → resource acquisition according to planning (e.g., formulation of digitalization policy, introduction of digitalization technology, etc.) → resource-based implementation → acceleration of government functions transformation (refer to Fig. 1). The implementation phase often revolves around constructing digitalization platforms. This emphasis arises from the necessity for digitalization planning, policies, and technologies facilitated by planning and resource factors to harness the informational and execution benefits of digitalization platforms (e.g., resource aggregation, distribution, and matching). These platforms expedite government functions transformation by fostering information exchange, equitable regulation, collaborative supervision, credit monitoring, and intelligent governance [22,23].

2.1.2. Functions outputs in government digitalization: Behaviours, performance and transformation

Government digitalization drives government functions transformation, a consequence evident in current research which analyzes organizational change from two angles: behavior and performance. Behavior entails cost inputs, unexpected events, and shifts in behavior, while performance involves comparing reform goals, predicting future conditions, and institutional progress [24]. Government functions transformation, as an adaptive change, encompasses shifts in behavior and performance enhancement. Understanding it as a blend of behavior and performance illuminates its complexity and diverse stakeholder involvement. Government functions transformation, as an adaptive change, encompasses shifts in behavior and improvements in performance. This dual perspective, examining it at both the behavioral and outcome levels, enhances comprehension of its complexity as a holistic system. Moreover, it recognizes the richness and diversity of processes and stakeholders involved. This study delves into the outputs of government digitalization driving government functions transformation across two dimensions: behavior and performance.

Behavior of Government Functions Transformation (BGFT) reflects government's external activities adapting to digital reform impact. Activities include constructing rule-of-law, responsible, limited, transparent, and service-oriented government processes.[1]

Performance of Government Functions Transformation (PGFT) reflects governments' intrinsic characteristics in economic regulation, market supervision, social management, public services, and ecological protection. Changes in behavior and performance hinge on public perception. Genuine public experience of BGFT change and PGFT improvement signifies achieved government functions transformation.

2.1.3. An Analytical Framework Based on Structural Functionalism

When government digitalization starts from top-level design and proceeds top-down, it often results in a Weberian-style administrative system, characterized by rational, standardized, and impartial behaviors [25]. Higher-level digitalization planning creates institutional pressure, intensified during execution, prompting local governments to implement safeguards and enhance digitalization technology breadth and depth for better outcomes. Research shows increased digitalization technology intensity accelerates government functions transformation [26,27], altering departmental collaboration, supervisory accountability, and improving execution.

Resources play a pivotal role in determining system structural characteristics. Conversely, the structure influences which institutional and non-institutional resources the system can mobilize [28]. Sustainable resource exchange, flow, and linkage improve inter-organizational relationships and goal achievement [29]. However, resource endowments vary across countries and regions due to factors like geography, strategic planning, and culture. Within existing endowments, local governments adjust and optimize structures to drive transformative efforts efficiently. Digitalization planning, policies, and technologies introduced by planning-related and resource-related factors leverage the information and execution advantages of digital platforms for effective function fulfillment, such as "transaction facilitators" and "behavior supervisors" (refer to Fig. 2).

2.2. Research hypotheses

2.2.1. Driving path of digitalization planning

In China, the relationship between planning and complementary policies plays a crucial role in driving development. The mechanism of central decision-making, planning, and local policy implementation enables the separation of supervision and policy execution [30]. The introduction of digitalization planning by higher-level governments often exerts top-to-down institutional pressure, leading to the implementation of complementary digitalization policies due to resource constraints such as talent, capital, information, and knowledge. While higher-level governments typically formulate the "Digital China" plan, local governments develop

[1] Rule-of-law government signifies a shift from administrative methods to legal mechanisms in fulfilling governmental functions. Responsible government ensures alignment with legally mandated responsibilities, particularly in social management and environmental protection. Limited government operates within authorized powers, especially in economic regulation and market supervision. Transparent government entails the gradual proactive disclosure of government data to society. Service-oriented government prioritizes a "citizen-centered" ideology.

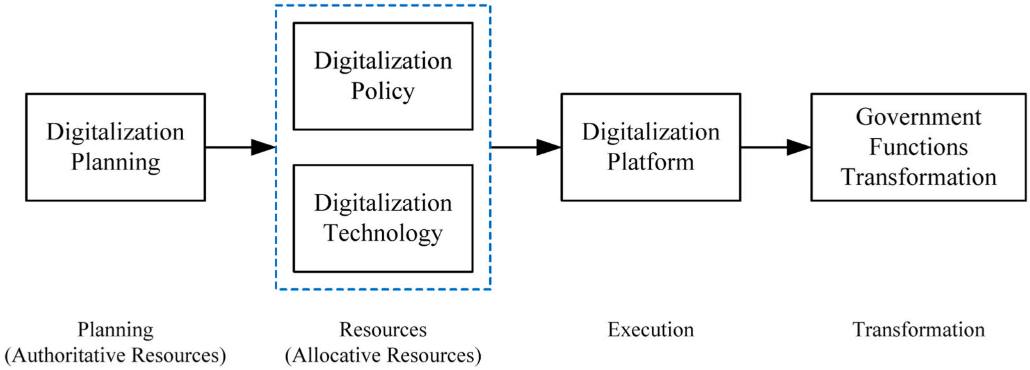


Fig. 1. Dimension and conduction paths of government digitalization.

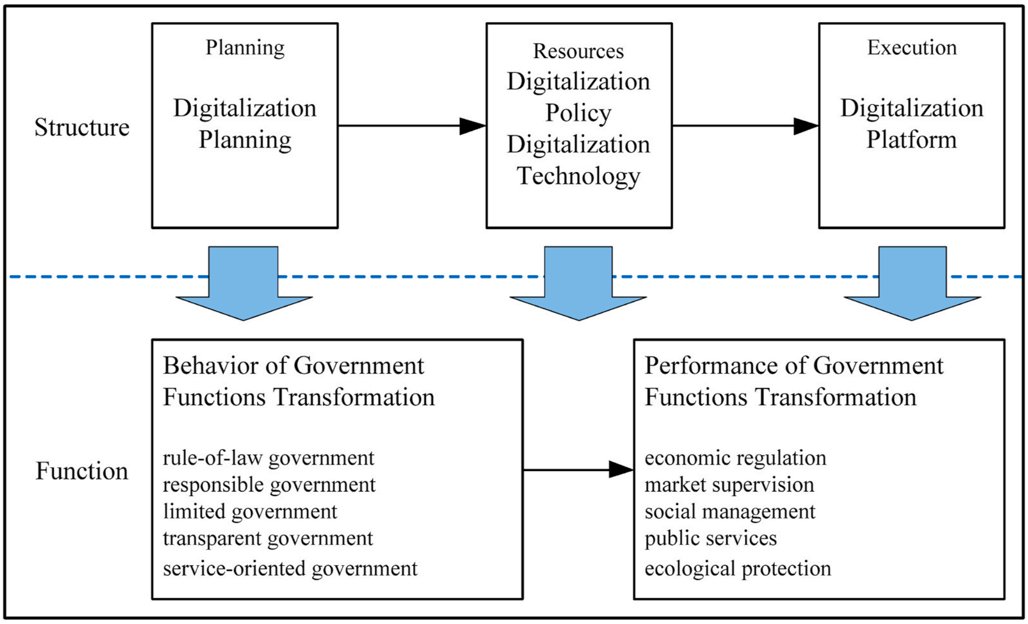


Fig. 2. An analytical framework based on Structural Functionalism.

digitalization policies to support its execution, creating a path from planning to execution.

Both central and local levels exhibit a close connection between digitalization planning and technologies. The formulation and execution of digitalization planning can enhance local governments' digitalization technology breadth and intensity. During execution, considering the supply and demand of digitalization technologies is crucial for better outcomes. Thus, the following hypotheses are proposed.

H1a. Digitalization planning positively impacts digitalization policies.

H1b. Digitalization planning positively impacts digitalization technologies.

2.2.2. Driving path of digitalization policy

Digitalization planning aids the execution of digitalization policies and enhances platform capabilities. Higher-level governments may exert "top-down" pressure, compelling local governments to meet plan objectives. However, local governments often face resource constraints, lacking talent, funding, information, and knowledge. Thus, digitalization policies are crucial for plan completion. Implementing supportive digitalization policies can strengthen platform capabilities, enabling local governments to acquire digitalization resources to build platforms and enhance communication, collaboration, and innovation.

H2a. Digitalization policies positively impact digitalization platforms.

Digitalization policies interconnect policy entities into a network, influencing BGFT and enhancing government capacities, policy execution incentives, and PGFT [31]. This relationship forms a "policy planning → policy execution → policy performance" pathway, evident in public policy practices in Western countries like the United States and the United Kingdom [32]. Therefore, the following hypotheses are proposed.

H2b. Digitalization policies positively impact BGFT.

H2c. Digitalization policies positively impact PGFT.

2.2.3. Driving path of digitalization technology

Local digitalization planning mirrors central-level planning, with national plans like the "Digital China Construction Overall Plan" aiming to utilize various platforms with distinct functionalities [33]. Local government digitalization planning inherently includes platform construction. Examination of digitalization plans at different levels reveals that they require technology acquisition for platform development and digitalization reforms. With robust policy execution mechanisms in China, enhancing platform capabilities is feasible. Local governments often accumulate digitalization technology through methods such as outsourcing and introduction after planning. Therefore, the following hypothesis is proposed.

H3a. Digitalization technologies positively impact digitalization platforms.

2.2.4. Driving path of digitalization platform

Building a digitalization platform involves sharing and reusing digitalization resources (such as talent, funds, and data). There are three main paths for constructing integrated digitalization platforms: (1) Trading Platform Path: The government coordinates resources to create a public service platform, facilitating transactions between various actors [34–36]. (2) Innovation Platform Path: The government fosters innovation among actors through integrated services, datasets, and open government data, creating an Open Data Platform (OGD) [37]. (3) Collaborative Platform Path: The government encourages internal communication within agencies by building collaborative platforms, outsourcing digital tasks to enterprises and social organizations [38,39], or collaborating with external entities [40].

Implementing digitalization planning requires expanding platform functionalities. Effective digitalization planning enhances platform functions, and greater expansion of these functions can accelerate the transformation of BGFT. For example, the "Guidelines for Industry and Industrial Brain Construction" issued by Zhejiang Province on March 28, 2022, mandates unified standards for industry data warehouses, promoting data aggregation, system integration, and collaborative innovation.

Strengthening platforms' functionalities can enhance PGFT. For instance, improving digitalization planning reinforces mobile governance platforms, enabling governments to overcome spatial limitations and sustainably enhance mobile office convenience. Powerful mobile governance platforms facilitate efficient communication and collaboration for public servants, aiding in fulfilling their duties. Similarly, in law enforcement and supervision, enhancing information-sharing within platforms aids in social interaction and market supervision, contributing to improve PGFT [41]. Therefore, the following hypotheses are proposed.

H4a. Digitalization platform positively impacts BGFT.

H4b. Digitalization platform positively impacts PGFT.

2.2.5. Driving path within government functions transformation

The key to government functions transformation depends on adjusting government roles according to modernization requirements.

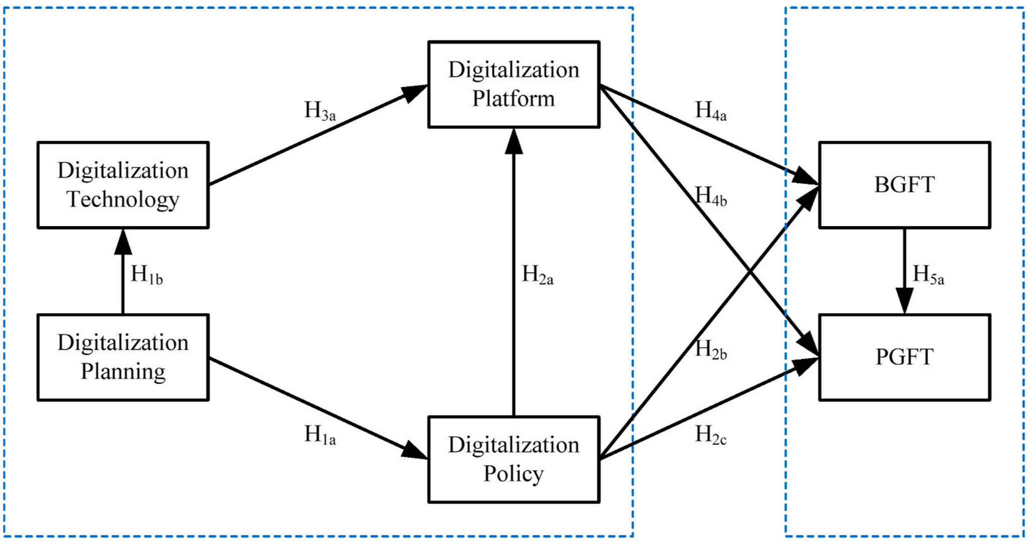


Fig. 3. Conceptual model for government digitalization to drive government functions transformation.

In the digital era, government functions are not only reflected in passive and external changes of BGFT, but also in proactive and internal enhancements of PGFT, aligning with public perception. Ignoring PGFT can result in superficial digitalization [6], limited public participation [42], and negative citizen experiences [43]. Government functions transformation begins with passive changes in BGFT, progressing towards rule-of-law, responsible, limited, transparent, and service-oriented governance. Reforms aim to improve PGFT for better public experience in economic regulation, market supervision, social management, public services, and environmental protection. Therefore, the following hypothesis is proposed.

H5a. BGFT positively impacts PGFT.

2.2.6. Conceptual model for government digitalization to drive government functions transformation

Building upon the aforementioned hypotheses, we propose a conceptual model for government digitalization to drive government functions transformation (refer to Fig. 3). Government digitalization planning utilizes digitalization policy, technology, and platforms to coordinate the coordination of resource planning and platform support, expediting government functions transformation.

3. Materials and methods

3.1. Empirical approach

Given the advantages of Structural Equation Model (SEM) in analyzing multiple causal relationships, we employ this method to empirically test the impact of government digitalization on government functions transformation. SEM is a statistical method used to analyze causal relationships between variables based on their covariance matrix. It illustrates the causal link between latent variables (LV) and manifest variables (MV), such as digitalization planning and policy, which cannot be directly measured. Observational variables are explicit indicators used to measure these latent variables, typically obtained through surveys or interviews.

The analysis comprises two models: the measurement model, which scrutinizes the relationship between observed and latent variables, and the structural model, which explores the relationships among latent variables. This paper conducts hypothesis testing of the proposed research model alongside discussions on government digitalization, government functions transformation, and their associated observational variables. These relationships are expressed through three matrix equations:

Measurement models are

$$X = \mathbf{\Lambda}_X \xi + \delta \tag{1}$$

$$Y = \mathbf{\Lambda}_Y \eta + \varepsilon \tag{2}$$

Structural model is

$$\eta = \mathbf{B}\eta + \mathbf{\Gamma}\xi + \zeta \tag{3}$$

Here, in the equation, δ, ε, ζ denote measurement error terms. X represents the latent variable of external derivatives, while ξ is the latent variable vector. $\mathbf{\Lambda}_X$ denotes the component matrix of X on ξ, reflecting the relationship between exogenous indices and exogenous latent variables. Y represents the inner latent variable, with η denoting the inner derivative latent variable vector. $\mathbf{\Lambda}_Y$ represents the component matrix of Y on η, signifying the relationship between endogenous indicators and endogenous latent variables. The coefficient matrix $\mathbf{B}$ describes the interaction between latent variables η, while the coefficient matrix $\mathbf{\Gamma}$ elucidates the influence of external latent variables ξ on internal latent variables η.

3.2. Variables and indicators

Despite the absence of objective indicators, we utilize subjective indicators to gauge respondents' perceptions, ensuring research validity through appropriate design [44]. To enhance the practicality and feasibility of indicators, we have devised a concise expert consultation form grounded in theoretical evaluation indicators derived from literature research. Experts, scholars, and civil servants specializing in government digitalization, government functions transformation, and digitalization governance are invited to participate in these consultations. Building on their feedback and recommendations, we have refined our indicators, culminating in a comprehensive system for evaluating government digitalization and government functions transformation.

Government digitalization primarily comprises four variables (dimensions): Digitalization Planning, Digitalization Policy, Digitalization Technology, and Digitalization Platform. Meanwhile, government functions transformation mainly involves two variables (dimensions): BGFT and PGFT. Specific indicator names and their corresponding literature references are provided in Table 1.

3.3. Data source

For accuracy and relevance, this study selects county-level governments as its research subjects. County-level administrative units represent one of the oldest historical administrative systems in China, playing a crucial role in government administration and serving as a vital link between various levels of government [62]. Furthermore, county-level governments are the most accessible to the public among all government tiers, facilitating a deeper understanding of governance structure, behavior, and capacity.

SEM is employed to analyze the driving mechanism of government digitalization on government functions transformation,

Table 1
Indicators for measuring government digitalization and government functions transformation.

Variables	Indicators and Literature References
Digitalization Planning	X11 Clarity and rationality of overall goals for digitalization planning [45]
	X12 Reasonable allocation of responsibilities among leading and collaborating units in the digital planning [46]
	X13 Absence of conflicts between annual goals and tasks in the digital planning [46]
	X14 Feasibility of achieving digital planning goals under existing technological conditions [47]
	X15 Adequate economic resources to support the implementation of digital planning goals [47,48]
	X16 Strong execution capability of local government (including human and material resources) to ensure the implementation of digital planning [47,48]
	X17 Alignment of local government's execution of digital planning with public values [47,48]
Digitalization Policy	X21 Cost of related supporting policies within an appropriate range for the local government [49]
	X22 Consideration of different stakeholders' needs in basic supporting policies [49]
	X23 Balancing resource inputs and outputs in the implementation of related supporting policies [49,50]
	X24 Visible effectiveness in the implementation of related supporting policies [49]
Digitalization Technology	X31 Preference for technology introduction over independent development in the local digital technology context [51,52]
	X32 Availability of strong 5G network infrastructure to support digital technology use in the area [51,52]
	X33 Dedicated digital technology professionals engaged in development in the area [51,52]
	X34 Emphasis on local needs-driven redesign of digital technologies rather than direct imitation [51,53]
	X35 Application of local digital technology can enhance overall work performance [54]
	X36 Availability of specialized technical training to assist users in utilizing digital technologies [54]
Digitalization Platform	X41 High frequency of public use of government service platforms [35,36,54]
	X42 User-friendly and convenient experience when using government service platforms [35,36,54]
	X43 Minimal data exchange barriers between departments within the platform (horizontal integration) [35,37,54]
	X44 Efficient information exchange between government service platforms at different levels (vertical integration) [35,37,54]
	X45 Most relevant data and information about local government work are published on relevant platforms [40,54,55]
	X46 Involvement of Public-Private Partnerships (PPPs) in the construction of government service platforms [40,54,55]
BGFT	Y11 Continuous improvement in government's adherence to legal administration [56,57]
	Y12 Increasing awareness of government's responsibility and duties [56,57]
	Y13 Growing emphasis on "no authority without legal authorization" during government duties [56,57]
	Y14 Gradual proactive disclosure of data by the government to the public [58]
	Y15 Enhanced service mindset among government departments [57,59]
PGFT	Y21 Active implementation of policies benefiting enterprises by the government [60]
	Y22 Market dominance in resource allocation [57,61]
	Y23 Transition of government-society relations toward cooperation [57]
	Y24 Increased public acceptance of public policies [57]
	Y25 Heightened government focus on ecological environment protection [57]

exploring potential differences across China's East, Center, and West regions. Existing literature offers two perspectives on the required sample size for SEM. One suggests a minimum of 100–200 samples [63–65], while the other recommends determining sample size based on the item-to-respondent ratio. For example, Hatcher proposes a minimum ratio of 5:1 [66], whereas Hogarty and others suggest 20:1 [67]. To ensure scientific rigor and account for resource constraints, we estimate questionnaire distribution using a 20:1 ratio. Since separate structural equation models will be developed for the East, Center, and West regions, a minimum of 600 questionnaires is required from each. Considering response rates and invalid questionnaires, we plan for approximately 700 questionnaires from each region, totaling 2100 survey participants.

To ensure the survey accurately reflects the average level within each region while preventing over-concentration of respondents from specific locations, we limit the number of questionnaires collected from each county-level administrative unit to 2–5, with an average of 3.5. Thus, 700 questionnaires should cover approximately 200 county-level administrative units. To enhance representativeness, this study relies on data from the "Statistical Tables of Administrative Divisions of People's Republic of China (as of December 31, 2022)"[2] for allocation. Questionnaires are distributed in proportion to the number of county-level administrative units under the jurisdiction of each provincial district, relative to its location in the East, Center, and West. For selecting county-level administrative units within each province, all units were uniformly numbered, and selections were made using random number generation. Team members or volunteers in different provinces distributed and collected questionnaires through various methods, including interviews, mail, email, WeChat, and online platforms. If any unit faced restrictions due to surveyor connections or questionnaire quality, preventing distribution or collection after repeated confirmation and verification, additional units were randomly selected to ensure coverage. Respondents include government staff, employees of enterprises and institutions, faculty and staff of colleges and universities, and members of the public. Questionnaire distribution began in September 2022 and continued until April 2023, resulting in 2131 valid responses. Most researchers and their connections are based in the eastern and western regions, making real-time control of questionnaire distribution and recovery challenging, especially those handled via WeChat and online platforms. Constraints like time and budget also contributed to deviations in the number of recovered questionnaires and coverage of county-level units across provinces. Nevertheless, the survey generally met program requirements, and the sample remained reasonably representative. The questionnaires cover 205 county-level administrative units in the East, 183 in the Center, and 171 in the West,

[2] http://xzqh.mca.gov.cn/statistics/2022.html.

representing 30 provincial-level administrative units nationwide (see Table 2).

According to Table 3, the survey questionnaires exhibit a relatively balanced gender distribution, with male and female respondents each accounting for nearly half. Regional distribution shows that the East comprises 795 responses, representing 37.3 % of the total, while the Center and West account for 29.3 % and 33.4 %. Respondents predominantly fall between the ages of 21 and 40, with some representation in the 41–50 and 51–60 age brackets. When queried about their familiarity with topics such as "government digitalization" and "government functions transformation" (rated on a scale from 1 as the lowest to 5 as the highest), over 80 % of respondents provided ratings of 3 or higher, indicating a relatively informed understanding of these concepts.

4. Results

4.1. *Test of validity and reliability*

We tested the validity and reliability of survey questionnaires by selecting 1 MPA class each from Zhejiang University and Guizhou University. A pilot test of the questionnaire was conducted, distributing 124 questionnaires, resulting in 98 valid responses. Employing exploratory factor analysis, we examined the questionnaires' validity. For the government digitalization section, the Kaiser-Meyer-Olkin (KMO) measure yielded a value of .879, and the Bartlett's Test of Sphericity produced a p-value significantly below the significance level. Four factors extracted broadly aligned with the theoretically derived dimensions of government digitalization. All indicators, except for the indicator X23, fell into their expected dimensions. The cumulative variance contribution of the four extracted factors was 52.046 %, indicating strong explanatory power and high validity for this section.

Additionally, the data for the government functions transformation section yielded a Kaiser-Meyer-Olkin (KMO) measure of .779, and the Bartlett's Test of Sphericity produced a p-value significantly below the significance level. The extracted factors showed that indicators Y11 to Y15 measuring BGFT belong to one common factor, while indicators Y21 to Y25 assessing PGFT form the other, aligning with the theoretically derived dimensions of government functions transformation. The cumulative variance contribution of the two extracted factors was 45.135 %, indicating strong explanatory power and high validity for this section (see Table 4).

We employed Cronbach's Alpha Coefficient to test reliability. For the government digitalization section, the overall Cronbach's

Table 2
Regional distribution of questionnaires.

Province	Number of county-level administrative units	Proportion in the East (Center/West)	Estimated number of county-level administrative units covered	Actual number of county-level administrative units covered	Actual number of questionnaires
Beijing	16	1.85 %	4	5	16
Tianjin	16	1.85 %	4	5	15
Hebei	167	19.26 %	39	33	144
Liaoning	100	11.53 %	23	23	93
Shanghai	16	1.85 %	4	6	23
Jiangsu	95	10.96 %	22	22	91
Zhejiang	90	10.38 %	21	31	99
Fujian	84	9.69 %	19	16	76
Shandong	136	15.69 %	31	34	122
Guangdong	122	14.07 %	28	24	95
Hainan	25	2.88 %	6	6	21
Shanxi	117	13.24 %	26	23	74
Jilin	60	6.79 %	14	11	43
Heilongjiang	121	13.69 %	27	20	82
Anhui	104	11.76 %	24	21	70
Jiangxi	100	11.31 %	23	18	63
Henan	157	17.76 %	36	33	107
Hubei	103	11.65 %	23	25	83
Hunan	122	13.80 %	28	32	103
Inner Mongolia	103	9.43 %	19	11	53
Guangxi	111	10.16 %	20	20	72
Chongqing	38	3.48 %	7	8	37
Sichuan	183	16.76 %	34	31	118
Guizhou	88	8.06 %	16	21	94
Yunnan	129	11.81 %	24	21	85
Tibet	74	6.78 %	14	–	–
Shaanxi	107	9.80 %	20	18	76
Gansu	86	7.88 %	16	16	68
Qinghai	44	4.03 %	8	8	33
Ningxia	22	2.01 %	4	3	10
Xinjiang	107	9.80 %	20	14	65
Total	2843	–	600	559	2131

Table 3
Demographic characteristics of the sample.

Characteristics		Freq.	Relative Freq.	Characteristics		Freq.	Relative Freq.
Gender	Male	1221	57.3	Familiarity of Government Functions Transformation	1	137	6.4
	Female	910	42.7		2	160	7.5
Region	East	795	37.3		3	528	24.8
	Center	625	29.3		4	739	34.7
	West	711	33.4		5	567	26.6
Age	−20	133	6.2	Familiarity of Government Digitalization	1	104	4.9
	21–30	701	32.9		2	170	8.0
	31–40	689	32.3		3	525	24.6
	41–50	348	16.3		4	698	32.8
	51–60	246	11.5		5	634	29.8
	61-	14	.7	Qualifications	Bachelor or below	1099	51.6
					Master	801	37.6
					PhD	231	10.8

Alpha Coefficient was .911, while digitalization planning, digitalization policy, digitalization technology, and digitalization platform had Cronbach's Alpha Coefficients of .719, .751, .756, and .724 respectively. Thus, we conclude that the government digitalization section demonstrates high reliability both overall and across its dimensions. For the government functions transformation section, the Cronbach's Alpha Coefficients reached .780, indicating satisfactory reliability for the overall assessment.

4.2. *Confirmatory factor analysis*

We conducted a confirmatory factor analysis (CFA) using AMOS 21.0 to validate the dimensions of government digitalization and government functions transformation. The former model comprises four latent variables: Digitalization Planning, Digitalization Policy, Digitalization Technology, and Digitalization Platform, measured by 7, 4, 6, and 6 observed variables, while the latter comprises two latent variables: BGFT and PGFT. The results (Table 5) indicate that the path coefficients representing the influence of each latent variable on observed variables are statistically significant, confirming the validity of the impact pathways. Moreover, the majority of standardized coefficients exceed .60, demonstrating that each observed variable effectively reflects the content of the corresponding latent variable.

The fit indices of the CFA model indicate that out of the 17 commonly used fit indices, 13 meet or nearly meet the standards in government digitalization,[3] and 14 meet or nearly meet the standards in government functions transformation [4]. Additionally, the p-values for the correlations between the various dimensions of government digitalization and government functions transformation are significantly below the significance level (as shown in Table 6), indicating clear relationships between the variables.

4.3. *Results of structural equation model*

4.3.1. *Fitting effects on National Scale*

The initial structural equation model comprises 6 latent variables and 33 observed variables, including 33 error variables (e1 to e33) and 5 disturbance variables (e34 to e38).The overall fit indices used to assess the external quality of the model demonstrate that the initial structural equation model has good fit. However, regarding the path coefficients in the model, except for the path from Digitalization Platform to PGFT, which has a p-value significantly higher than the significance level, all other path coefficients pass the significance test, suggesting targeted modifications are needed. The revised results are depicted in Fig. 4 after removing the aforementioned path and re-estimated the model parameters:

The revised structural equation model demonstrates good fit based on the fit indices.[5] Regarding the path coefficients in the model (as shown in Table 7), all seven paths have coefficients that pass the significance test, indicating that Model 2 exhibits high internal quality.

4.3.2. *Fitting effects within each region*

795 valid questionnaires from the East were incorporated into the model to validate the driving mechanisms of government digitalization on government functions transformation. The initial structural equation model revealed that the path coefficient from Digitalization Policy to BGFT significantly exceeded the significance level. The revised results are depicted in Fig. 5 after removing the aforementioned path and re-estimating the model parameters:

[3] RMSEA = .042, GFI = .956, AGFI = .946, NFI = .961, RFI = .956, IFI = .969, TLI = .965, CFI = .969, PGFI = .776, PNFI = .851, PCFI = .858, CN = 516.

[4] RMR = .034, RMSEA = .036, GFI = .988, AGFI = .981, NFI = .989, RFI = .985, IFI = .992, TLI = .989, CFI = .992, PGFI = .611, PNFI = .747, PCFI = .749, CN = 809.

[5] RMSEA = .039, GFI = .942, AGFI = .933, NFI = .951, RFI = .947, IFI = .963, TLI = .959, CFI = .963, PGFI = .818, PNFI = .878, PCFI = .888, CN = 562.

Table 4
Rotating component matrix of government digitalization and government functions transformation.

	Components					Components					Components	
	1	2	3	4		1	2	3	4		1	2
X33	.770				X45			.599		Y15	.770	
X32	.738				X42			.574		Y12	.738	
X34	.561				X41			.564		Y13	.644	
X36	.545				X44			.507		Y11	.465	
X31	.544				X43			.455		Y14	.384	
X35	.536				X46			.446		Y23		.717
X14		.708			X21				.736	Y22		.658
X16		.665			X22				.599	Y21		.648
X17		.663			X24				.510	Y25		.581
X15		.605								Y24		.446
X11		.552										
X13		.547										
X23		.543										
X12		.427										

Table 5
Path coefficients of confirmatory factor analysis.

			Standardized Estimate	P				Standardized Estimate	P
X17	<—	Digitalization Planning	.751		X36	<—	Digitalization Technology	.777	
X16	<—	Digitalization Planning	.769	***	X35	<—	Digitalization Technology	.717	***
X15	<—	Digitalization Planning	.752	***	X34	<—	Digitalization Technology	.794	***
X14	<—	Digitalization Planning	.696	***	X33	<—	Digitalization Technology	.726	***
X13	<—	Digitalization Planning	.630	***	X32	<—	Digitalization Technology	.671	***
X12	<—	Digitalization Planning	.700	***	X31	<—	Digitalization Technology	.470	***
X11	<—	Digitalization Planning	.731	***	X41	<—	Digitalization Platform	.664	
X24	<—	Digitalization Policy	.767		X42	<—	Digitalization Platform	.746	***
X23	<—	Digitalization Policy	.779	***	X43	<—	Digitalization Platform	.733	***
X22	<—	Digitalization Policy	.767	***	X44	<—	Digitalization Platform	.781	***
X21	<—	Digitalization Policy	.742	***	X45	<—	Digitalization Platform	.695	***
					X46	<—	Digitalization Platform	.699	***
Y11	<—	BGFT	.780		Y21	<—	PGFT	.762	***
Y12	<—	BGFT	.792	***	Y22	<—	PGFT	.722	***
Y13	<—	BGFT	.738	***	Y23	<—	PGFT	.737	***
Y14	<—	BGFT	.711	***	Y24	<—	PGFT	.754	***
Y15	<—	BGFT	.713	***	Y25	<—	PGFT	.765	***

Table 6
Relationships between latent variables in confirmatory factor analysis model.

			Covariances Estimate	Correlations Estimate	S.E.	C.R.	P
Digitalization Planning	<→	Digitalization Policy	1.358	.946	.057	23.723	***
Digitalization Policy	<→	Digitalization Technology	1.510	.899	.064	23.514	***
Digitalization Planning	<→	Digitalization Technology	1.506	.902	.064	23.416	***
Digitalization Policy	<→	Digitalization Platform	1.018	.849	.048	21.250	***
Digitalization Planning	<→	Digitalization Platform	1.027	.862	.048	21.259	***
Digitalization Technology	<→	Digitalization Platform	1.246	.895	.057	21.796	***
BGFT	<→	PGFT	1.254	.947	.052	24.049	***

The revised structural equation model demonstrates good fit based on the fit indices.[6] Regarding the path coefficients in the model (as shown in Table 8), all seven paths have coefficients that pass the significance test, indicating that the Model 2 exhibits high internal quality.

Similarly, 625 valid questionnaires from the Center and 711 valid questionnaires from the West were used to validate the driving mechanisms in these regions. Some fit indices in the initial structural equation model for the Center and West did not meet the

[6] RMSEA = .021, GFI = .951, AGFI = .944, IFI = .968, TLI = .965, CFI = .967, PGFI = .827, PNFI = .820, PCFI = .894, CN = 648, Chi-square to degrees of freedom ratio = 1.358.

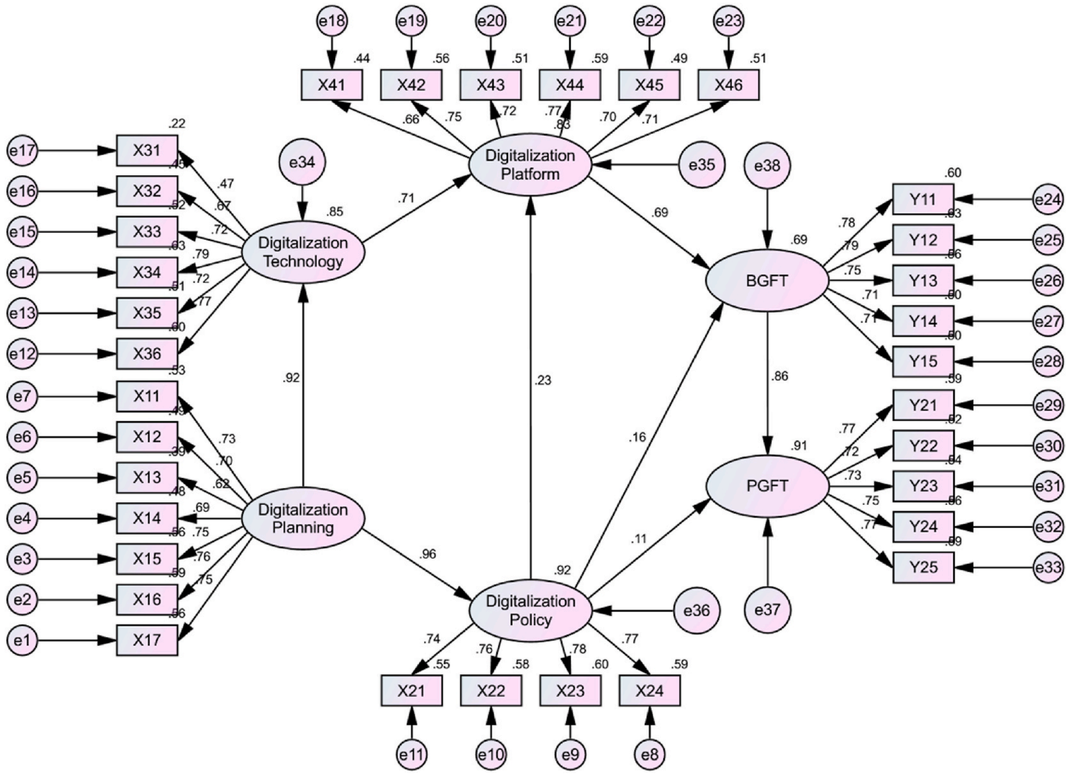


Fig. 4. The revised structural equation model (national scale, model 1).

Table 7
Path coefficients of revised structural equation model (national scale).

			Covariances Estimate	Correlations Estimate	S.E.	C.R.	P
Digitalization Technology	<—	Digitalization Planning	1.075	.920	.031	34.164	***
Digitalization Policy	<—	Digitalization Planning	.969	.961	.028	34.845	***
Digitalization Platform	<—	Digitalization Technology	.505	.706	.037	13.492	***
Digitalization Platform	<—	Digitalization Policy	.187	.225	.040	4.714	***
BGFT	<—	Digitalization Platform	.784	.688	.053	14.692	***
BGFT	<—	Digitalization Policy	.154	.163	.040	3.871	***
PGFT	<—	BGFT	.892	.863	.034	26.437	***
PGFT	<—	Digitalization Policy	.112	.115	.025	4.572	***

standards. Referring to the parameter modification indices provided by AMOS 21.0, covariances were established between certain error terms, and paths with p-values significantly higher than the significance level were removed. The re-estimated model parameters are depicted in Fig. 6:

Model3[7] and Model4[8] demonstrate good fit based on the fit indices. Regarding the path coefficients in the model (as shown in Table 9), all paths have coefficients that pass the significance test, indicating that the Model 3 and Model 4 exhibits high internal quality.

5. Discussion

5.1. Overall characteristics

Statistical tests in Model 1 confirm the research hypotheses, with 8 out of 9 hypotheses supported (see Table 10).

[7] RMSEA = .049, NFI = .908, RFI = .900, IFI = .943, TLI = .938, CFI = .943, PGFI = .778, PNFI = .836, PCFI = .868, CN = 277, Chi-square to degrees of freedom ratio = 2.500.
[8] RMSEA = .086, NFI = .904, RFI = .894, IFI = .918, TLI = .909, CFI = .918, PGFI = .680, PNFI = .820, PCFI = .833.

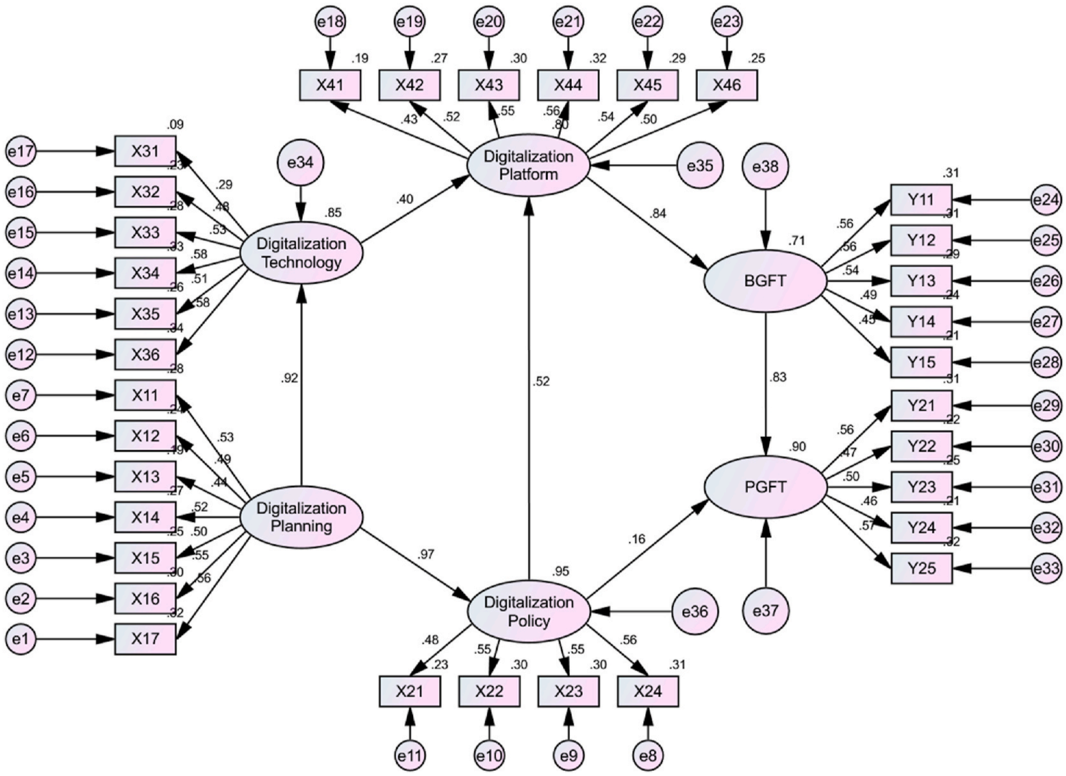


Fig. 5. The revised structural equation model (The East, model 2).

Table 8
Path coefficients of revised structural equation model (The East).

			Covariances Estimate	Correlations Estimate	S.E.	C.R.	P
Digitalization Technology	<—	Digitalization Planning	1.012	.920	.083	12.167	***
Digitalization Policy	<—	Digitalization Planning	.924	.974	.077	12.050	***
Digitalization Platform	<—	Digitalization Technology	.251	.398	.139	1.803	.071
Digitalization Platform	<—	Digitalization Policy	.378	.518	.161	2.356	.018
BGFT	<—	Digitalization Platform	1.119	.841	.117	9.543	***
PGFT	<—	BGFT	.875	.827	.115	7.628	***
PGFT	<—	Digitalization Policy	.161	.157	.088	1.834	.067

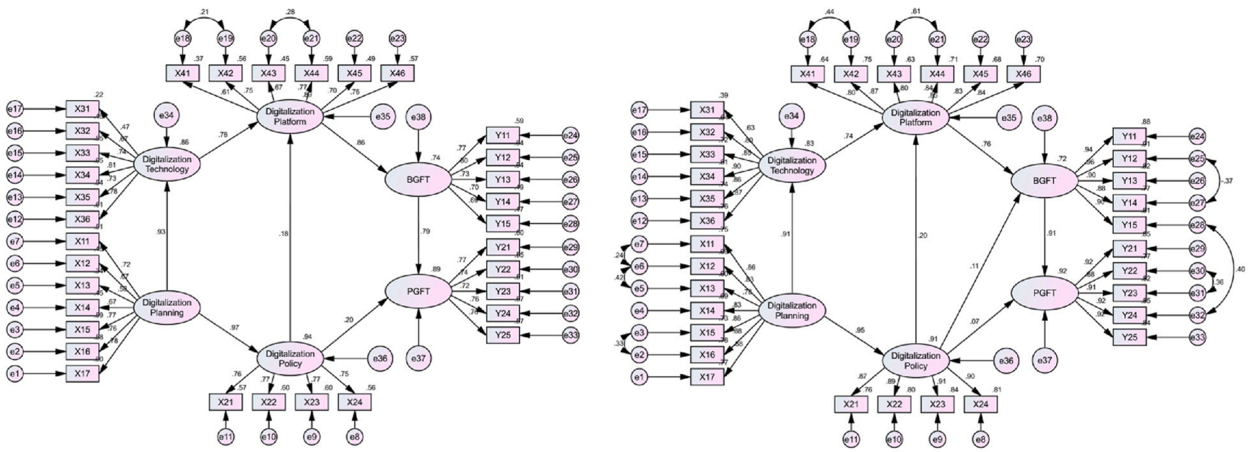
Fig. 7 illustrates the driving mechanism of government digitalization on government functions transformation.

The AMOS output provides standardized direct, indirect, and total effects, which are summarized in Table 11.

Digitalization planning is pivotal in government functions transformation through government digitalization, with a notable impact (.961) on digitalization policy. Authoritative resources (digitalization planning) guide the acquisition and application of allocative resources (digitalization policies), as suggested by Structural Functionalism. Research emphasizes the benefit of separating central digitalization planning from local policy implementation [31]. With ranking second among all variable relationships, digitalization planning significantly influences digitalization technology (.920), fostering its accumulation and application by local governments. Analysis of digitalization policy texts like the “Digital China Construction Overall Plan” underscores the link between digitalization planning and technology, mandating sustainable enhancement of technology reserves to overcome reform hurdles.

Digitalization technology (.706) notably advances digitalization platforms, serving as allocative resources that drive government functions transformation through execution factors (i.e., digitalization platforms). Empirical results emphasize its role in facilitating transformation. Organizational change theory suggests that resource factors influence execution factors, subsequently affecting organizational change [68]. Thus, the indirect impact of government functions transformation stems from digitalization technology’s direct influence on digitalization platforms.

Digitalization policies exert significant influence on digitalization platforms, BGFT, and PGFT. On-site research in Zhejiang Province, China, underscores the heavy reliance of digitalization platforms on digitalization policy support. Digitalization policies provide essential resources such as manpower, finance, infrastructure, and data, crucial for platform establishment and operation.



(a) (b)

Fig. 6. (a) the revised structural equation model (The center, model 3); (b) the revised structural equation model (The West, model 4).

Table 9
Path coefficients of revised structural equation model (The Center and West).

			Covariances Estimate	Correlations Estimate	S.E.	C.R.	P
The Center							
Digitalization Technology	<—	Digitalization Planning	1.041	.927	.053	19.513	***
Digitalization Policy	<—	Digitalization Planning	.942	.969	.049	19.238	***
Digitalization Platform	<—	Digitalization Technology	.526	.776	.070	7.528	***
Digitalization Platform	<—	Digitalization Policy	.144	.184	.071	2.033	.042
BGFT	<—	Digitalization Platform	1.017	.862	.071	14.277	***
PGFT	<—	BGFT	.799	.786	.061	13.130	***
PGFT	<—	Digitalization Policy	.185	.197	.045	4.081	***
The West							
Digitalization Technology	<—	Digitalization Planning	1.052	.909	.038	27.959	***
Digitalization Policy	<—	Digitalization Planning	.959	.952	.030	31.942	***
Digitalization Platform	<—	Digitalization Technology	.558	.742	.043	12.928	***
Digitalization Platform	<—	Digitalization Policy	.171	.199	.045	3.850	***
BGFT	<—	Digitalization Platform	.877	.761	.067	13.189	***
BGFT	<—	Digitalization Policy	.105	.105	.052	2.031	.042
PGFT	<—	BGFT	.934	.909	.029	31.768	***
PGFT	<—	Digitalization Policy	.069	.067	.024	2.911	.004

Table 10
Results of research hypotheses.

Research Hypotheses		Results
H1a	Digitalization planning positively impacts digitalization policies	supported
H1b	Digitalization planning positively impacts digitalization technologies	supported
H2a	Digitalization policies positively impact digitalization platforms	supported
H2b	Digitalization policies positively impact BGFT	supported
H2c	Digitalization policies positively impact PGFT	supported
H3a	Digitalization technologies positively impact digitalization platforms	supported
H4a	Digitalization platform positively impacts BGFT	supported
H4b	Digitalization platform positively impacts PGFT	un-supported
H5a	BGFT positively impacts PGFT	supported

Small-scale reform projects necessitate startup funding ranging from 150,000 to 500,000 Chinese yuan, while larger initiatives require millions to tens of millions, facilitated by policy provisions.

Besides digitalization planning, digitalization platforms most significantly impact government functions transformation, particularly BGFT (.688) and PGFT (.594). As execution factors, they bridge planning, resources, and execution, enabling the influence of allocative resources on government functions transformation as a crucial intermediary. Expert interviews indicate that digitalization platforms in both the West and East of China feature information sharing, data reuse, collaborative interactions, and integrated

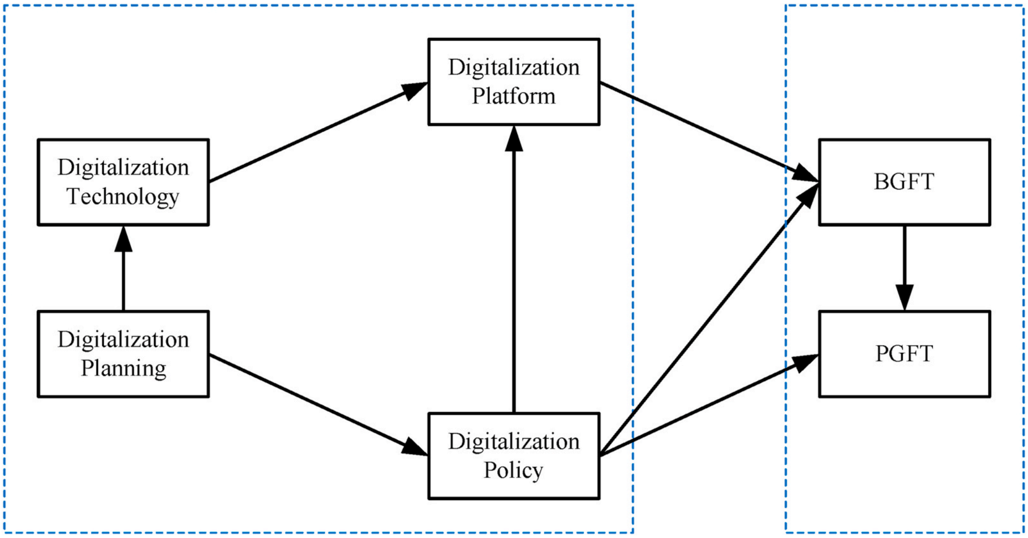


Fig. 7. The driving mechanism of government digitalization to drive government functions transformation.

Table 11
Standardized impact effects of latent variable paths.

Latent Variables Relationships	Direct Effects	Indirect Effects	Total Effects
Digitalization Planning → Digitalization Technology	.920	–	.920
Digitalization Planning→ Digitalization Policy	.961	–	.961
Digitalization Planning→ Digitalization Platform	–	.866	.866
Digitalization Planning→ BGFT	–	.753	.753
Digitalization Planning→ PGFT	–	.760	.760
Digitalization Technology → Digitalization Platform	.706	–	.706
Digitalization Technology → BGFT	–	.486	.486
Digitalization Technology → PGFT	–	.420	.420
Digitalization Policy → Digitalization Platform	.225	–	.225
Digitalization Policy → BGFT	.163	.155	.318
Digitalization Policy → PGFT	.115	.274	.389
Digitalization Platform → BGFT	.688	–	.688
Digitalization Platform → PGFT	–	.594	.594
BGFT → PGFT	.863	–	.863

synergy, facilitating transactions, collaboration, and innovation, thus optimizing BGFT and promoting PGFT through resource integration.

Empirical findings illustrate the internal impact of government functions transformation. The structural equation model indicates BGFT's substantial influence on PGFT (.863), highlighting their significance in government functions. BGFT manifests in external activities, while PGFT embodies internal characteristics. External BGFT as the cause drives internal PGFT representing the outcome.

5.2. Regional differences

Models 2, 3, and 4 delineate the driving mechanisms of government digitalization on government functions transformation in the East (Fig. 8), and West (aligned with the national level, Fig. 7).

Standardized impact effects of latent variable paths across the East, Center, and West are summarized in Table 12.

Digitalization Planning's impact on Digitalization Technology, Digitalization Policy, Digitalization Platform, BGFT, and PGFT remains consistent across the East, Center, and West of China, indicating its substantial influence with minimal regional variations. However, the impact of digitalization technology differs by region. Early adoption and rapid development of digitalization technology in the East has stabilized after initial breakthroughs, while the Center and West face bottlenecks due to delayed adoption, significantly hindering digitalization dividends.

The impact of digitalization platforms on BGFT slightly favors the Center over the East. This difference may stem from differing approaches; the East focuses on resource integration via digitalization technologies like Cloud Computing, IoT, and AI (e.g., Hangzhou's "City Brain"), while the Center, exemplified by Hefei, prioritizes tangible public convenience and service experiences. The influence of digitalization platforms on PGFT is notably higher in both the East and Center compared to the West, indicating consistent positive momentum for PGFT enhancement across regions.

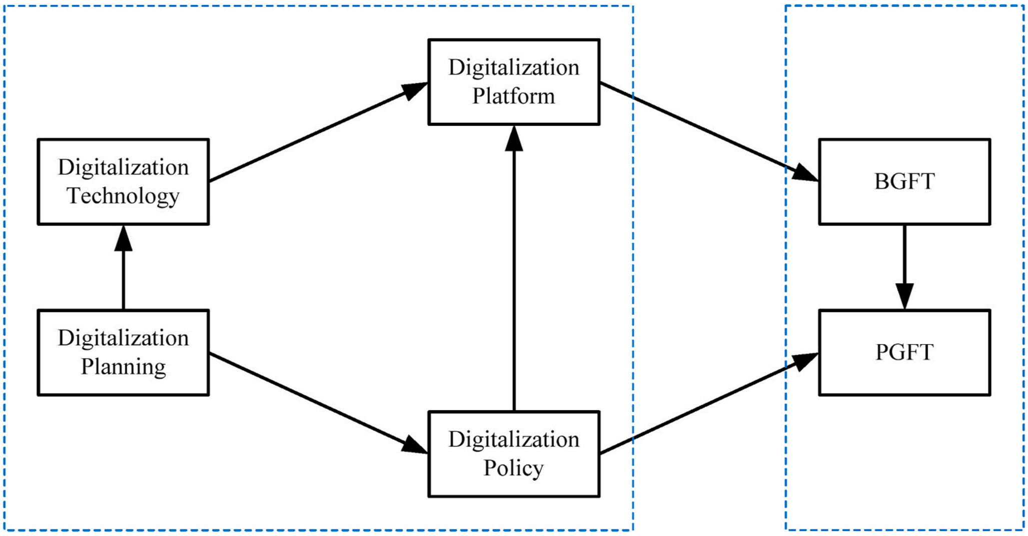


Fig. 8. The driving mechanism of government digitalization to drive government functions transformation (In the East and center).

Table 12
Standardized impact effects of latent variable paths across regions.

Latent Variables Relationships	Direct Effects			Indirect Effects			Total Effects		
	East	Center	West	East	Center	West	East	Center	West
Digitalization Planning → Digitalization Technology	.920	.927	.909	–	–	–	.920	.927	.909
Digitalization Planning→ Digitalization Policy	.974	.969	.952	–	–	–	.974	.969	.952
Digitalization Planning→ Digitalization Platform	–	–	–	.871	.898	.864	.871	.898	.864
Digitalization Planning→ BGFT	–	–	–	.733	.774	.757	.733	.774	.757
Digitalization Planning→ PGFT	–	–	–	.758	.799	.753	.758	.799	.753
Digitalization Technology → Digitalization Platform	.398	.776	.742	–	–	–	.398	.776	.742
Digitalization Technology → BGFT	–	–	–	.335	.669	.565	.335	.669	.565
Digitalization Technology → PGFT	–	–	–	.277	.526	.513	.277	.526	.513
Digitalization Policy → Digitalization Platform	.518	.184	.199	–	–	–	.518	.184	.199
Digitalization Policy → BGFT	–	–	.105	.436	.159	.151	.436	.159	.256
Digitalization Policy → PGFT	.157	.197	.067	.360	.125	.233	.517	.322	.300
Digitalization Platform → BGFT	.841	.862	.761	–	–	–	.841	.862	.761
Digitalization Platform → PGFT	–	–	–	.696	.677	.692	.696	.677	.692
BGFT → PGFT	.827	.786	.909	–	–	–	.827	.786	.909

Regional differences shape the impact of digitalization policy. In the East, Center, and West of China, the overall impact of digitalization policy on digitalization platform is .518, .184, and .199. In the East, policies significantly promote the development of digitalization platforms, enabling cross-sector integration, vertical coordination, information sharing, and public-private partnerships. This is primarily because the East has more abundant resources, such as capital and talent, which better support optimizing BGFT. In contrast, the West, with a less developed digital government infrastructure, prioritizes building foundational infrastructure and spreading technology. As of 2023, talent concentration in first-tier cities presents challenges for the West, despite recruitment efforts. Strategic hiring of business-oriented professionals with digitalization literacy can advance construction of a rule-of-law government, responsible government, limited government, transparent government, and service-oriented government, especially BGFT, beyond platform dependency in the current stage of digitalization policies in the West.

Second, the unique economic and social landscape in the West of China necessitates nuanced digitalization policy formulation and implementation. Considering the West's reliance on specific industries and its distinctiveness, policies should not be uniformly applied from the East. Integrating digitalization technologies and policies with regional development initiatives can yield synergies, bolstering policy implementation resources. Both digitalization policy traits and existing regional development strategies should be leveraged to enhance PGFT in the West.

6. Conclusions

According to Structural Functionalism, structure is defined as the rules and resources inherent in a continuously evolving social system. Globally, including in regions beyond China, a clear distinction exists between authoritative and allocative resources. Authoritative resources convert allocative resources into outputs through direction and management, making Structural

Functionalism's analytical framework and empirical findings widely applicable. This study constructs a theoretical framework for understanding the driving mechanisms of government digitalization on government functions transformation from a Structural Functionalism perspective. The framework relies on two premises: (1) Local government digitalization involves managing and utilizing various resources to achieve digitalization goals. Local governments often adjust and optimize their structures within resource constraints to drive reform efforts efficiently. (2) Government digitalization leads to changes in behavior, methods, and performance of government functions transformation, utilizing digital tools to adapt to the evolving needs of the digital era.

Structural Functionalism offers insights for developing a theoretical framework applicable across countries and regions: the driving factors and mechanisms for transforming government functions may vary based on the specific country, region, and time period. Digital technology is more than a mere tool for governance. Digital reform clarifies the operational sequence: "digitalization planning → resource acquisition → resource-based implementation → acceleration of government functions transformation". Restructuring government boundaries, organizational forms, and governance modes facilitates this transformation.

Based on empirical results, we recommend designing an institutional safeguard framework to promote the impact of government digitalization on government functions transformation. This framework encompasses four dimensions: (1) Digitalization planning guidance system at the macro level. Optimizing resource allocation and utilization methods at the macro-level focus on the total quantity, structure, and allocation direction of resources, ensuring alignment with digitalization planning and the overall development strategy of digitalization governance. (2) Digitalization policy assurance system at meso level. It focuses on resource supply, allocation, and oversight to ensure departments or units operates according to prescribed requirements and meets digitalization governance objectives. (3) Digitalization technology support system at micro level. Specific allocation, deployment, and management of resources are involved in facilitating the implementation of digitalization governance projects and initiatives. (4) Integrated digitalization platform. It encompasses three key aspects: data governance rules, regulations for collaborative partners, and performance evaluation systems, aiming to clarify rules, scope, and performance expectations for internal government resources and stakeholders.

While digitalization technologies offer opportunities to accelerate government functions transformation, challenges persist. Poor planning and incompatible technologies can increase administrative burdens and fragment government operations, blurring the lines between the state and society. Since no single entity possesses all necessary resources, an interdependent network is vital to drive change, demanding a reshaping of institutional rules. Additionally, much of the data for this study relies on volunteers across various provinces. Sample sizes in volunteers' hometowns and nearby areas are more adequate, but this approach does not match standard methods like systematic sampling although the problem has been recognized and responded. Future research will compare digitalization efforts across regions, emphasizing typicality and representativeness, to integrate the strengths of both quantitative and qualitative approaches.

Ethics statement

All participants provided informed consent to participate in the study and for the publication of all their data and images.

Funding

This work was supported by The National Social Science Fund of China (17CGL041).

Additional information

No additional information is available for this paper.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Fei Han: Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Diandian Zhang:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Funding acquisition, Formal analysis, Data curation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Diandian Zhang reports financial support was provided by The National Social Science Fund of China. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e37267.

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